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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

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VIA COURIER

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Ex Parte
CC Docket No. 01-77

Dear Ms. Dortch:

This letter provides additional information in support of the Petition for Declaratory Ruling ("Petition") filed by the Coalition of Competitive Fiber Providers ("Coalition") concerning application of Section 224(f)(1) of the Communications Act of 1934, as amended, to ILEC duct and conduit leading to, and in, ILEC central offices.[1] For the reasons stated herein and in the Petition, the Commission should determine that telecommunications carriers may, pursuant to Section 224(f)(1), terminate multi-strand optical fiber cabling in an Optical Cable Entrance Facility ("OCEF") in the central office vault, extend fiber cabling between the CLECs' collocation space and the OCEF in the vault, and perform fusion splicing at the OCEF in the vault.[2]

An OCEF is a type of fiber distribution frame ("FDF") suitable for use in wet or other hostile environments or otherwise unconditioned space. An FDF is used to terminate, and interconnect, optical fiber cabling. Individual fiber strands in a cable are separated and placed on a frame on the FDF, which permits both efficient identification of each strand and splicing with other fiber terminated on the FDF. FDFs can vary in size depending on how many fiber strands are in the associated optical cabling. A photograph of an OCEF is provided in Attachment A to this letter. As indicated in Attachment A, the largest OCEF offered by Lucent measures only 42" x 30" x 12" and thus would occupy minimal space in the vault.

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[1] *Pleading Cycle Established for Comments On Petition of Coalition of Competitive Fiber Providers for Declaratory Ruling of Sections 251(b)(4) and 224(f)(1),* Public Notice, CC Docket No. 01-77, DA 01-728, March 22, 2001.

[2] Among other telecommunications services provided by members of the Coalition, Telseon Carrier Services, Inc. provides "managed bandwidth" service.

No. of Copies rec'd 0+2
List ABCDE

It is not acceptable practice to terminate and interconnect multi-strand fiber optic cabling by means of numerous separate splices outside of an FDF. This would unduly complicate identification of individual strands of fiber, and threaten network reliability because fiber must be adequately protected from water and dust and physically supported in a frame to prevent breakage. Further, because an FDF permits ready identification of fiber strands in a cable, FDFs are essential to facilitate disaster recovery.

FDFs are also necessary in contemporary telecommunications networks because it is rarely practical to install continuous runs of fiber between carriers, or between customers and carriers. Instead, an FDF permits efficient configuration and interconnection, including changes in configuration and interconnection arrangements, of fiber optic cabling. For these reasons, industry practice dictates that an FDF is the only practical method for terminating and interconnecting multi-strand optical fiber cabling interconnecting several carriers. Because it is not possible, as a practical matter, to install and maintain fiber without using FDFs, unduly restrictive terms or conditions of use can preclude or hinder use of fiber optic cabling.

The central office vault is a structure, sometimes a room, located in, or immediately adjacent to, the central office that receives cable or wiring from outside the central office. It is usually underground. The vault is the first structure in the central office that receives wiring from the street. Attachment B to this letter presents a diagram showing a typical location of the cable vault in relation to the rest of the central office. Attachment C to this letter provides photographs of the interior of a vault in an ILEC central office showing copper and fiber cabling.

ILECs use their own duct and conduit leading to, and in, ILEC central offices to distribute fiber cabling. ILECs run multi-strand fiber cabling from the manhole nearest the central office ("manhole zero") through duct and conduit under the street to the central office vault. Ordinarily, ILECs do not install continuous runs of fiber from outside the central office to CLECs collocated in the central office because it is impractical to do so for the reasons described above. Depending on individual ILEC practices, the ILEC may terminate the cable in an FDF located in the vault or in an FDF in some other area of the central office. Attachment D is a schematic diagram developed by BellSouth in connection with its technical specifications for unbundled dark fiber showing fiber cable entering the vault and then terminating in an FDF.[3]

Other than Verizon, pursuant to its Competitive Alternate Transport Terminal tariff,[4] ILECs do not permit carriers to terminate multi-strand fiber cabling at an FDF in the central office. SBC and BellSouth permit competitive fiber providers ("CFPs") and other carriers to install an FDF, if at all, no closer to the central office than in a connection point further from the central office than "manhole zero." In many cases, the CFP must create this connection point

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3 Unbundled Dark Fiber Technical Specifications, Technical Reference, TR 73603, February 1999, Issue A, p. 8. (Attachment D hereto.)

4 Verizon FCC Tariff No. 1, Section 19.10.3. A noted by Qwest, Verizon's CATT approach benefits both CFPs and ILECs by, among other reasons, permitting CFPs to use unconditioned space in the central office. Qwest Comments, CC Docket No. 01-77, filed April 23, 2001, p. 13.

itself by creating its own manhole or rebuilding and expanding an ILEC manhole. Upon request of a collocated CLEC, the ILEC will pull individual fiber strands, for a charge, from the CFP's connection point into the vault for termination on an ILEC FDF. Thus, SBC in connection with its Section 271 application for Oklahoma, stated that it will pull CLEC fiber from "the last entrance manhole at the SWBT central office or tandem switch location ...to the SWBT cable vault for termination on the SWBT fiber distribution frame."[5]

The ILECs'limitation on terminating multi-strand fiber cabling in an FDF only in a connection point at some distance from the central office materially and seriously discriminates against CFPs because it delays up to several months the time within which CFPs can provide service, and substantially increases costs to CFPs and their customers. ILECs charge the CFP or CLEC each time they pull a fiber strand into the central office. For an optical cable with 432 fiber strands, this could amount to nearly $1 million in unnecessary charges for utilization of every strand in such a cable.[6] In contrast, as noted, ILECs extend their own fiber cabling directly into the central office for connection to the ILEC FDF. ILECs are able thereby to achieve the efficiencies and substantial cost savings of one pull into the central office per cable, thus gaining a significant cost advantage in providing loop and transport services, in comparison to other facilities-based carriers. These additional charges for multiple pulls into the central office, as well as the significant time delays involved, are totally unnecessary and discourage facilities-based competition. ILEC requirements for multiple pulls also discourage facilities-based competition by causing premature and unnecessary exhaustion of building entrances (conduit and duct) space, which provides ILECs a further justification for denying or delaying access to the central office, which is perhaps ILECs' purpose in imposing these discriminatory requirements.

As discussed, termination of fiber in an FDF is inherent in use of optical fiber cabling, and, therefore, also is an indispensable feature of access to ILEC duct and conduit. Without the ability to use FDFs in an efficient manner in accordance with industry practice, CFPs and other carriers are deprived of meaningful access to ILEC duct and conduit. The Coalition requests that the Commission determine that the prohibition on termination of multi-strand fiber in an FDF in the central office violates the nondiscrimination obligations of Section 224(f)(1). In order to provide nondiscriminatory access to ILEC duct and conduit as required by Section 224(f)(1), ILECs must permit CFPs and other telecommunications carriers to install multi-strand fiber cabling in central office duct and conduit and terminate it in an FDF on approximately the same terms and conditions that would apply to the ILECs' use in their own operations.

However, it is not necessary for CFPs and other carriers to terminate fiber in an FDF in precisely the same locations in the central office as ILECs, although this could be required under the nondiscrimination standard of Section 224(f)(1). Instead, current ILEC practices which

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[5] Affidavit of William C. Deere on Behalf of Southwestern Bell Telephone Co., CC Docket No. 00-217 p. 9.

[6] Verizon under its CATT tariff permits CFPs to terminate 432 strand fiber cabling at an FDF in the central office. Verizon Tariff FCC No. 1 Section 19.10.3 (B).

unlawfully restrict access to duct and conduit could be sufficiently corrected if ILECs are required to permit termination of fiber cabling in an FDF in the central office vault, or, if no space is available in the vault, in an area near the vault. In addition, the Commission should determine that CFPs and CLECs may, pursuant to Section 224(f)(1), access ILEC duct and conduit in the central office in order to extend fiber between the CLECs' collocation space and the OCEF in the vault. Similarly, ILECs must permit CFPs and other carriers to perform fusion splicing in order to provide nondiscriminatory access to duct and conduit as required by Section 224(f)(1). Fusion splicing is the standard industry method for splicing fiber on FDFs, and ILECs routinely perform fusion splicing in the vault.[7]

The Commission may make these requested determinations in order to assure meaningful and nondiscriminatory access to ILEC duct and conduit, as required by Section 224(f)(1). Furthermore, the central office vault constitutes conduit under the Commission's rules. Section 1.1401(i) of the Commission's rules defines conduit as "a structure containing one or more ducts, usually placed in the ground, in which cables or wiring may be installed." As noted, the ILEC central office vault is usually below ground and serves the purpose of receiving and holding cabling that enters the central office from the street. It is a structure in which cables and wiring are installed. Thus, central office vaults fall squarely within the Commission's definition of conduit, and, requiring that ILECs permit installation of OCEFs in vaults does not involve occupation of ILEC property other than duct and conduit. Therefore, the Commission may require ILECs to permit termination of fiber on an FDF in the vault in order to assure nondiscriminatory access to ILEC duct and conduit.

In addition, as discussed in the Petition, the facilities leading to, and in, ILEC central offices used to hold, support, and distribute cabling constitute duct and conduit. ILECs' tariffs, among other ILEC documents, describe these facilities in ways that make clear that the central office has numerous wiring distribution systems that constitute duct and conduit. Thus, Ameritech's access tariff imposes charges for use of central office "entrance conduit" and "innerduct," which it describes as extending from outside the central office to a splice point in the vault.[8] Ameritech also describes charges for pulling cable through the "riser," which it describes as running from the vault to the customer's collocation space in the central office.[9] Verizon, in its interstate access tariffs, describes facilities used to distribute CLEC fiber from the vault to central office equipment as "tubing."[10] Verizon also states that it will install CLEC fiber in the "Cable Support Structure" running from the vault to the collocation space.[11] ILECs' descriptions of these structures, whether as tubing, innerduct, conduit, risers, or cable support structures, and their function as permitting fiber to be pulled through them, are an admission that

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7 *See, e.g.* Verizon FCC Tariff No. 1, Section 19.3.5(B)(4), effective April 28, 2001.

8 Ameritech Operating Companies, FCC Tariff No. 2, Section 16.3.6(B)(1)-(6).

9 *Id.*

10 Verizon FCC Tariff No. 1, Section 19.3.5(B)(4), effective April 28, 2001.

11 *Id.*

these structures are duct and conduit. It is disingenuous, therefore, for ILECs in their comments in this proceeding to have represented to the Commission that their central offices contain no duct or conduit.[12] As explained in the Petition, all of these wiring distribution systems constitute duct and conduit within the meaning of the Commission's rules.

Accordingly, the Coalition requests that the Commission determine that telecommunications carriers may, pursuant to Section 224(f)(1), terminate multi-strand optical fiber cabling in an OCEF in the central office vault, extend fiber cabling from the vault to CLECs collocated in the central office, and perform fusion splicing at the OCEF in the vault, or other location of the OCEF.

Sincerely,

Patrick J. Donovan
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12 BellSouth Comments, CC Docket No. 01-77, filed April 23, 2001, p. 5.

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Jeffrey Carlisle
Christopher Libertelli
Michelle Carey
Eric Einhorn
Brent Olson
William Kehoe
Jack Yachbes
Linda Kinney
Debra Weiner

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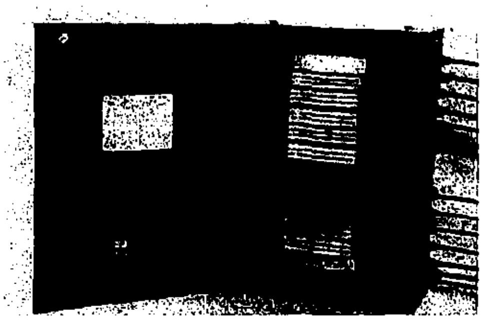
ATTACHMENT A

Optical Cable Entrance Facility (OCEF)



EF1-720/42 Side-Entry OCEF

The Optical Cable Entrance Facility (OCEF) cabinets are water-resistant enclosures intended for storing a large number of fiber splices between OSP and building-type cables in vault locations. The cabinets accommodate Lucent Lightpack, riser, and Building Cable sizes from 0.25-inch to 1.0-inch OD (0.64 to 2.54 cm).

The cabinet is designed to accommodate multiple cable sheaths through ports in the bottom, sides, and top. Cable entry ports are sealed, resulting in a National Electrical Manufacturers Association (NEMA) 4/12/13 rating — which means this unit provides protection against dust and water spray. Each cabinet incorporates a hinged, removable, lockable door that provides additional security.

The cabinet accepts the standard splice organizer tray, allowing complete access to any splice without disturbing other splices. The splice tray provides integrated strain relief for all types of fiber cable and buffer construction. Splice trays are designed for mechanical or fusion splices. The OCEF comes with a self-contained workshelf.

The OCEF enclosures are provided in two sizes. Each size OCEF may be ordered for either side entry or top and bottom entry.

OCEF Dimensions and Capacities

Product Code	Height	Width	Depth	Weight	# of Splices	# of Cables
OCEF1-288/22	22" (55.88 cm)	30" (76.2 cm)	12" (30.48 cm)	100 lb. (220.5 kg)	288	48
OCEF2-288/22	22" (55.88 cm)	30" (76.2 cm)	12" (30.48 cm)	100 lb. (220.5 kg)	288	24
OCEF1-720/42	42" (106.68 cm)	30" (76.2 cm)	12" (30.48 cm)	175 lb. (385.8 kg)	720	84
OCEF2-720/42	42" (106.68 cm)	30" (76.2 cm)	12" (30.48 cm)	175 lb. (385.8 kg)	720	24

ATTACHMENT B

(see page 3)

oOutside Plant Basics

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TelecomWriting.com Home

E-mail me!

- Telephone history series
- Mobile telephone history
- Telephone manual
- Digital wireless basics

- Cellular telephone basics
- Jade Clayton's pages
- Dave Mock's pages

- Seattle Telephone Museum
- Telecom clip art collection

- Britney Spears & telephones
- Bits and bytes
- Packets and switching

Search TelecomWriting.com Advanced search

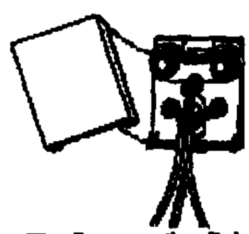
The Wired Local Loop/ Books on OSP?/ Link to a Digital Loop Carrier Tutorial / The Wireless Local Loop / Norman Rockwell and OSP (really neat) / Outside Plant -- A Woman's Experience

The Basic Elements of Outside Plant

A single wire does not run from your house to the central office. A communication path is maintained, instead, by a collection of wires and cable, mostly twisted pair, often in large bundles, that connects like a chain to different equipment. Let's take one common example.

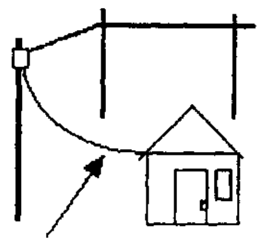
We'll follow your phone line from your house to the nearest CO or central office. This example combines aerial and buried plant. Let's assume that you live in an older neighborhood in a medium sized town. The kind with telephone cable running through the neighborhood's backyards on poles.

1. Telephone wiring inside your house first connects to the telco's wire at the *house protector* or *station protector*. This is the *demarcation point*. Your wiring ends here and the telco wiring begins.



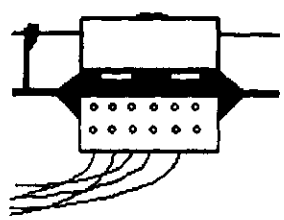
1. The Demarcation Point

2. From here a *drop wire* containing several twisted pair goes to a *pole closure, an aerial terminal* or *ready access terminal*. Call it what you will, this is the termination of the subscriber's drop wire. Drop wires can be thirty feet long or thousands of feet in length. They contain several twisted pair, only the oldest drops containing a single twisted pair.



2. Aerial Drop Wire

3. The customer's twisted pair is connected to binding posts within the enclosure. Depending on the enclosure, a wire representing your twisted pair may now be connected to the aerial cable servicing your neighborhood. This sort of enclosure is inline with the aerial cable and may serve as a connecting or splice point. Or, a wire from the back of the enclosure may run to a *splice case* nearby. This marries the enclosure's wire with the larger aerial cable that services your area.

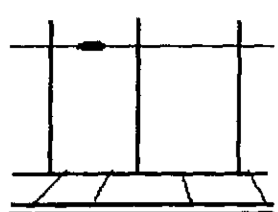


3. Aerial Service Terminal

4. This cable contains at least 50 pairs, commonly 100 or more. It's called *distribution cable* or *aerial cable* or F2 for being the *secondary feeder cable*. Several F2 cables may work their way back to the nearest SAI.

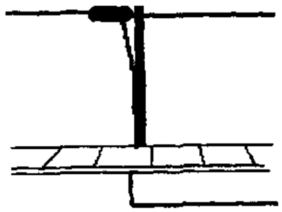
Click here for a picture of a standard aerial service terminal

And here's a picture of an aerial service terminal for fiber optic cable



4. Aerial cable or F2

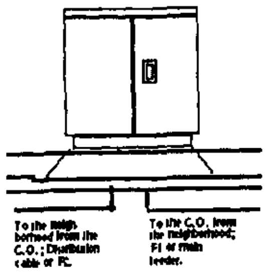
5. These F2 cables go underground via conduit before connecting to the *serving area interface*. In some areas the feeder does not go underground but is carried directly by the poles to the Serving Area Interface, which is described next.



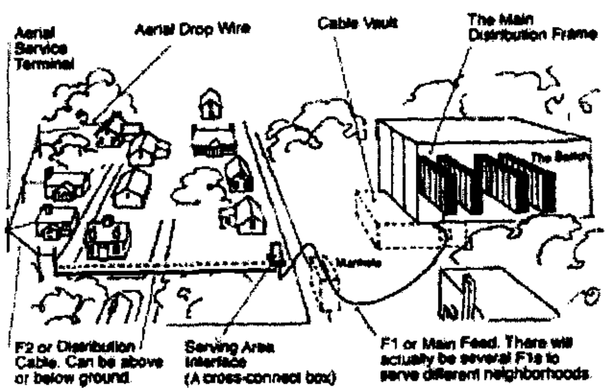
5. Distribution cable goes underground

6. The SAI or serving area interface. A big terminal block. Called B-Boxes, cross-connect boxes and APs, or Access Points. Whatever! Those ubiquitous gray-green cabinets you see nearly everywhere. They are usually mounted on the ground but can also be located on poles. F2 cable pairs connect with F1 pairs at this point. It's here that the individual twisted pairs are terminated. F1 or main feeder cables then go underground in conduit, usually to the nearest central office or remote switch. Or first to transmission equipment like a multiplexer and then to the C.O.

Click here for a picture of a typical cross connect box.



6. The Serving Area Interface



Once your signal hits the telephone switch it gets converted from an analog signal to a digital one. Although exceptions may exist, all traffic in America between telephone switches is now digital. Only traffic in the local loop as described above remains analog, but, again, everything goes digital once it hits a switch.

Courtesy of Jade Clayton's Telecom Dictionary:

1.) Picture of a central office distribution frame

2.) Picture of a cable vault

Resources

If you want to know what those strange looking telco cabinets and housings are for, the ones you see around your neighborhood, go to Marconi's site and take a look at their product catalog. Great learning:

http://www.marconi.com/html/solutions/outside plant.htm

Here's another good company site:

http://media.telecomosp.com/downloads/pdf/copper/ds/dsacbs.pdf

Outside plant specifications, both aerial and buried. Detailed info:

http://www.usda.gov/rus/telecom/publications/bulletins.htm (external link)

The following describes, extensively, *inside* building procedures for telecom. You should take a look.

http://www.wa.gov/doc/Content/Telecom/Index.html

A comment . . .

"The problem with OSP is that everyone forgets it's still the basic core for the majority of telephony. Some think that Digital is all there is -- but you still have to have the local loop F1 (fiber or copper) for the span line, the system, and the F2 distribution loop to the customer. Or people think wireless is all there is. All the latest technology is very important but it won't replace the local loop for decades to come. Maybe never really."

"My friends in OSP say that we are the forgotten children or the step-children. But the telephone company can't function without us. We are the working grunts however. While IOF (inter-office facilities), Switch, and Wireless think *they* are all of it, they actually have just one piece of the pie."

Our anonymous OSP authority. . .

Digital Loop Carrier Tutorial

This telco.com tutorial seems good. It starts out this way,

"This tutorial-level presentation OF Digitall loop carrier (DLC) technology is for both nontechnical readers and the technically versed who lack network applications experience. It describes DLC technology with a focus on the primary motivations for its development. Other topics include a comparison to channel bank technology, the organization of DLC technology in North America, and a comparison of universal digital loop carrier (UDLC) and integrated digital loop carrier (IDLC) technologies. The concluding topic illustrates a functional equivalence between DLC and fiber-in-the-loop technologies. Although three generations of DLC technology have brought an abundance of features and capabilities, this paper sticks to the basics to remain instructional. Discussion is limited to North American DLC technologies. . . .

http://www.telco.com/products_solutions/WhitePapers/digital/page1.html (external link)

Books on OSP?

It is absolutely impossible to find books on OSP. I have one, Lee's, but it is quite dated. You'll be lucky to find any of the titles below. Try OSP Magazine instead. GTE also had a book or a series but I don't even have a title for it. This is all the information I have on these long out of print books, you may have to search Amazon, e-bay, and abe.com just to find one. Don't forget, though, this resource I mentioned above:

http://www.usda.gov/rus/telecom/publications/bulletins.htm (external link)

Books

Outside Plant, Frank K. Lee. Quite dated. Far too much on open wire construction.

Available here, along with many other tutorial books and videos:

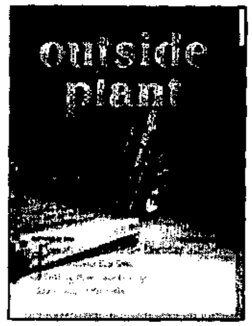
http://www.abcteletraining.com/trainingmanuals.htm (external link)

Outside Plant Construction: Cable Maintenance Methods, Bell System. I am not sure whether this is a series or not, I think so. See the title below which suggests that it is.

Handbook Of Outside Plant Engineering, AT&T.

Standard Outside Plant Construction Methods., Book 1, Section 1--

Pole line construction. Compiled, edited, and produced by Kellogg switchboard and supply co. Chicago, Kellogg switchboard and supply co. [c1945] 1 v. incl. illus, tables, diagrs. 11 1/2 x 18 1/2cm.

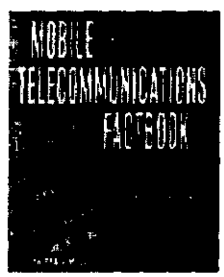


Outside Plant Magazine (external link) is an excellent resource. Look for the numerous, helpful files in their back issue section. Many topics covered from an OSP point of view. Well worth checking out!

The Wireless Local Loop

I haven't written on the wireless local loop, but Nathan Muller sure has. Check out his excellent introduction to WLL in a chapter from the McGraw Hill Mobile Telecommunications Factbook.

Chapter 9. The Wireless Local Loop (7 pages, 280K in .pdf)



Reviews and Ordering information (external link to Amazon.com)

The Wired Local Loop/ Books on OSP?/ Link to a Digital Loop Carrier Tutorial / The Wireless Local Loop / Norman Rockwell and OSP (really neat)

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because they do not have an affiliate program yet. But I've used and recommended them since late '95; you will be very happy with them.

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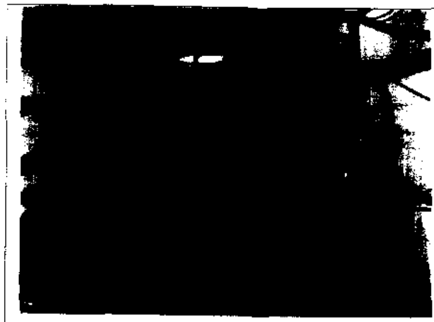
E-mail me!

TelecomWriting.com: West Sacramento, California USA

ATTACHMENT C

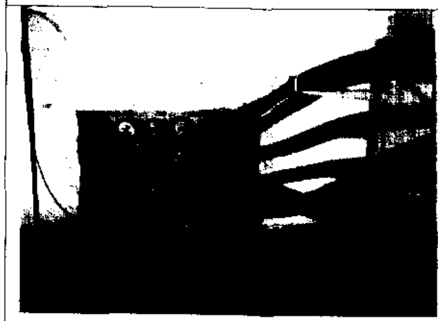
ATTACHMENT C



Picture 1

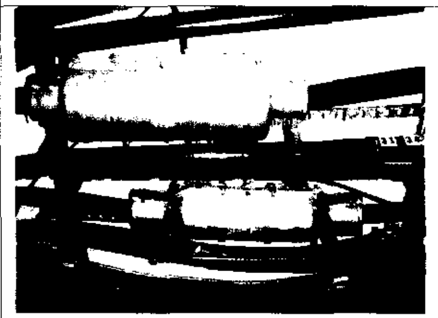
Picture 2

Picture 3

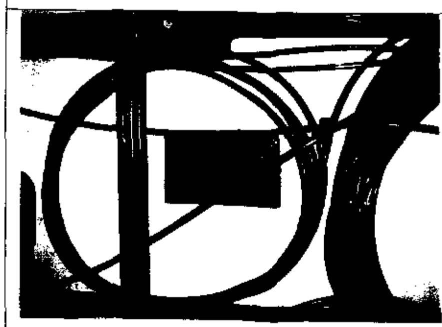


Picture 4

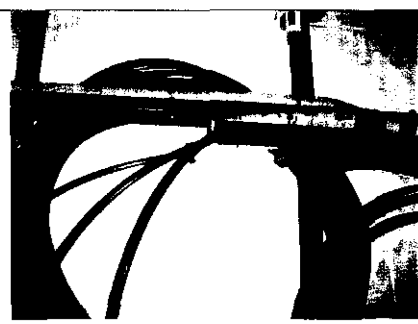
Picture 5



Picture 6



Picture 7



Picture 8

Picture 9

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ATTACHMENT D

(see pg. 8)

TR 73603

BELLSOUTH TELECOMMUNICATIONS

Unbundled Dark Fiber (UDF) Technical Specifications

Technical Reference

February, 1999
Issue A

NOTICE

This Technical Reference describes Unbundled Dark Fiber (UDF). This Unbundled Network Element (UNE) can provide a Competive Local Exchange Carrier (CLEC) a fiber transmission path between customer designated preimises and a BellSouth Telecommunications, Inc. (BST) Serving Wire Center or between BST Central Offices.

BellSouth Telecommunications, Inc., reserves the right to revise this document for any reason, including but not limited to, conformity with standards promulgated by various governmental or regulatory agencies, utilization of advances in the state of the technical arts, or the reflection of changes in the design of any equipment, techniques, or procedures described or referred to herein. Liability to anyone arising out of use or reliance upon any information set forth herein is expressly disclaimed, and no representations or warranties, expressed or implied, are made with respect to the accuracy or utility of any information set forth herein.

This document is not to be construed as a suggestion to any manufacturer to modify or change any of its products, nor does this document represent any commitment by BellSouth Telecommunications, Inc., to purchase any product whether or not it provides the described characteristics.

Nothing contained herein shall be construed as conferring by implication, estoppel or otherwise, any license or right under any patent, whether or not the use of any information herein necessarily employs an invention of any existing or later issued patent.

If further information is required, please contact:

Director – Transport Systems Engineering
BellSouth Telecommunications, Inc.
1884 Data Drive
Birmingham, Alabama 35244

Unbundled Dark Fiber (UDF) Technical Specifications

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Unbundled Dark Fiber (UDF) Technical Specifications

1. General

This document provides the technical specifications for Unbundled Dark Fiber (UDF) offered by BellSouth Telecommunications, Inc. (BST). This Unbundled Network Element (UNE) can provide a Competitive Local Exchange Carrier (CLEC) a fiber transmission path between a customer designated premises and a BST Serving Wire Center or between BST Central Offices. This service is sometimes referred to as Dry Fiber service but will be referred to as Dark Fiber service in this document. The term "dry" applies to the absence of DC power, whereas the term "dark" applies to the absence of regeneration.

1.1 Scope

This Technical Reference (TR) provides the technical specifications necessary for compatible operation between BST and CLECs. The requirements in this document were developed to establish a practical interface. Compliance with these specifications should provide a satisfactory interface in a high percentage of installations. If cases arise that have not been adequately addressed in this document, any resulting problems should be resolved through the cooperation of the user, BST and suppliers. BST encourages customer participation to ensure an orderly, functional and mutually trouble–free interface at all locations.

1.2 Use of This Document

Technical specifications have been established based upon Industry Standards developed by the American National Standards Institute (ANSI) and Bellcore. This TR articulates BST variations from these standards and provides clarification of specification and performance requirements as necessary.

2. Service Description

UDF service is offered as a point–to–point arrangement between a customer designated premises and BST Serving Wire Center or between BST Central Offices. UDF is offered without signal regeneration to compensate for signal losses. The service arrangement consists of four optical fibers and fiber terminating equipment as shown in Figure 1 and 2. UDF service will be routed through a BST Central Office for testing and maintenance functions. Current polices concerning recombination will be adhered to.

3. Network Rearrangements

BST reserves the right to rearrange its network and to modify the manner in which it provides service in order to meet its overall service requirements. This includes, but is not limited to, the right to engineer and construct its fiber optic facilities in accordance with its normal operations without the requirement to modify its materials, splicing techniques, or planned facility rearrangements to suit a specific customer request.

4. Fiber Transmission Media

UDF service shall be provided via single-mode fiber with a nominal zero dispersion wavelength at 1310 nanometers. The conventional dispersion-unshifted single-mode fiber (also known as EIA/TIA Class IVa fiber) shall generally meet the requirements detailed in Bellcore GR-20-CORE, *Generic Requirements for Optical Fiber and Optical Fiber Cables*, and ITU Recommendation G.652, *Characteristics of a Single-Mode Optical Fiber Cable.*

4.1 Operating Wavelengths

The service is provided over BST single-mode fiber optic cable which support operating wavelengths of 1310 nanometers (nm) and 1550 nm.

4.2 Typical Performance Characteristics

Table 1 provides typical characteristics of optical fiber and components commonly utilized in BST's network:

Table 1 – Typical Technical Characteristics of BST Optical Fiber and Components

Wavelength λ	1310 nm	1550 nm
Typical Fiber Loss	0.5 dB/km	0.35 dB/km
Discrete Reflectance (Splices, Connectors)	−40.0 dB	−40.0 dB
Return Loss (Fiber Cable)	+24.0 dB	+24.0 dB
Medium Zero Dispersion Wavelength	1310 ± 3 nm	Not Applicable
Chromatic Dispersion (Fiber Cable)	3.5 ps/nm−km	18.0 ps/nm−km
Chromatic Dispersion Slope (Fiber Cable)	0.093 ps/(nm−km^2)	0.093 ps/(nm−km^2)
Polarization Mode Dispersion (Fiber Cable)	10 ps	10 ps

The transmission characteristics of a specific UDF application may differ from the above typical performance characteristics.

5. Mechanical Interface

At the four fiber Network Interface (NI), BST will provide duplexable SC type (EIA/TIA SCFOC/2.5) plug and jack type connectors. BST will install the connector jack to serve as the NI. BST and the customer must each provide connector plugs to terminate their fibers at the NI. Each connector plug will contain 2 fibers, one for each direction of transmission. The connector jack will be the demarcation point between BST and the Customer Installation (CI). Figure 3 depicts the Fiber Optic Mechanical Network Interface.

5.1 Optical Fiber Termination and Arrangement

Optical fibers are terminated at the customer premises in a BST approved and constructed cabinet or Fiber Distributing Frame (FDF). BST typically uses a "tray" type splice on the customer premises and connectorized fibers from that splice to the cabinet or FDF.

6. Optical Power Limitations

Customer provided lasers shall not exceed +17.0 dBm in output power at 1550 nm (Class IIIb laser). In addition, the customer shall tell BST which class of laser (see Section 9) that they will be utilizing on their equipment.

7. Engineering Design Information

BST uses a design approach based on EIA/TIA−559, *Single−Mode Fiber Optic System Transmission Design,* and GR−253−CORE, *Synchronous Optical Network (SONET) Transport Systems: Common Criteria Physical Layer,* procedures for elements in its network.

For the purpose of optical parameter specifications, optical interfaces are referred to the Optical System Reference Diagram (Points S and R) as shown in Figure 4.

Point S is a reference point on the optical fiber just after the transmitter (Tx) optical connector(C_{Tx}). Point R is a reference point on the optical fiber just before the receiver (Rx) optical connector (C_{Rx}). Points S and R provide a convenient separation of the optical link into a transmitter subsection, a receiver subsection, and an optical path subsection. Optical parameters are specified for the transmitter at point S, for the receiver at point R, and for the optical path between Points S and R. All parameter values specified are worst−case values and are to be met over the ranges of standard operating conditions (i.e., temperature and humidity ranges); they include aging effects. The parameters are specified relative to an optical section design objective of a bit error ratio (BER) better than $1x10^{-10}$.

To ensure proper system performance it is necessary to specify attenuation and dispersion characteristics of the optical path. This specification is assumed to represent worst−case values including losses due to splices, connectors, optical attenuators (if used), or other passive optical devices, and any additional cable margin to cover allowances for the following:

(1) future modifications to the cable configuration (additional splices, increased cable lengths, etc.),

(2) fiber cable performance variations due to environmental factors, and

(3) degradation of any connector, optical attenuator (if used), or other passive optical device when provided.

For customer design purposes, BST will provide the following information, when it is available:

- Length of the fiber cable including 3% extra for possible cable reroute.
- Loss budget value in decibels/kilometer (dB/km) of fiber cable at $\lambda = 1310$ nm or $\lambda = 1550$ nm.
- Number of splices constructed and anticipated number of maintenance splices.
- Loss budget value of each splice in dB/splice.
- Loss budget value of single−mode fiber jumper in dB/jumper.

- Loss budget value of jumpers and connectors at the Lightguide Terminal Interconnect Equipment (LTIE) in dB at customer premises.
- Loss budget values of jumpers and connectors in dB used to connect fibers in BST office(s).

Note: **Loss Budget Values are end–of–life values which account for aging and are usually greater than actual measured values.**

8. Regeneration

UDF service is offered without regeneration, so it will be incumbent that the customer maintain, adequate margins to insure proper working of the fiber optic system.

9. Safety Requirements

The fiber optic system and required optical test equipment used in conjunction with UDF service must be registered and certified with the Department of Health, Education and Welfare Bureau of Radiological Health as specified in 21 CFR 1040.10. This document specifies performance requirements, labeling requirements and informational requirements. Documentation demonstrating system certification shall be available to assist in the determination of fiber optic safety precautions required to install, operate and maintain the system.

Optical powers from lasers are also classified by the International Electrotechnical Commission (IEC). Depending on the potential danger, IEC 825 requires that all laser equipment be classified into one of the following classes; 1, 2, 3a, 3b, or 4. Because the minimum power limits for class 4 lasers are not used in telecommunications, they are not considered for the purposes of this document. The other classes of lasers, the power limitations and the accompanying safety requirements are summarized in Table 2 on the following page.

Table 2 – IEC 825–1 and 825–2 Classes of Lasers, Power Limits & Safety Requirements

Laser	Maximum Power Levels		Safety Requirements
	1310 nm	**1550 nm**	
Class 1	9.4 dBm	10.0 dBm	Inherently Safe • Protective housing to prevent higher than classified emission. • Safety interlock in the housing to prevent access to non–classified emission levels. • Classification labels on the product and in the promotional literature. • Caution labels on service panels, interlocked or not • User safety information in operator and service manuals.
Class 2[1]	NA	NA	NA
Class 3a	13.8 dBm	17.0 dBm	Safe unless viewing aids are used Additional requirements to all of the above: • Key control • Beam stop to automatically disable the laser if no access is required. • Audible or visible "Laser On" warning.
Class 3b	27.0 dBm	27.0 dBm	Additional requirements to all of the above: • Remote control switch to allow disabling the laser by a door circuit. • Aperture label to indicate the location of the radiation output.

Special precautions and requirements for installation and use of optical systems (including amplifiers) and a description of viewing aids are given in IEC 825–2.

[1] Class 2 is used for visible laser products emitting wavelengths from 400 to 700 nm, these requirements are not considered pertinent.

10. Maintenance

The customer must cooperatively disable (turn–off) any optical transmission equipment on a dark fiber arrangement whenever BST must perform maintenance on those facilities.

11. References

GR–20–CORE, Generic Requirements for Optical Fiber and Optical Fiber Cable, Issue 1, September, 1994

GR–63–CORE, Network Equipment–Building System (NEBS), Generic Equipment Requirements, Issue 1, October 1995

GR–253–CORE, Synchronous Optical Network (SONET) Transport Systems: Common Criteria Physical Layer, Issue 2, December 1995

GR–326–CORE, Generic Requirements for Single–Mode Connectors and Jumper Assemblies, Issue 2, December 1996

Bellcore Technical References may be ordered by contacting:
Bellcore Customer Relations
8 Corporate Place – Room 3A–184
Piscataway, NJ 08854–4156
1–800–521–2673

EIA/TIA–559, Single–Mode Fiber Optic System Transmission Design

OFSTP–2, Effective Transmitter Output Power Coupled into Single–Mode Fiber Optic Cable

OFSTP–3, Fiber Optic Terminal Receiver Sensitivity and Maximum Receiver Input

OFSTP–10, Measurement of Dispersion Power Penalty in Single–Mode Systems

OFSTP–11, Measurement of Single Reflection Power Penalty for Fiber Optic Terminal Equipment

EIA/TIA documents may be ordered by contacting:
Telecommunications Industry Association
Engineering Department
2001 Pennsylvania Avenue N.W.
Washington, D.C. 20006
(202) 457–4966

IEC 825–1, Safety of Laser Products, Part 1: Equipment classification, requirements and user's guide, First Edition, 1993–11

IEC 825–2, Safety of Laser Products, Part 2: Safety of optical fiber communication systems, First Edition, 1993–09

ANSI Z136.2–1998, American National Standard for the Safe Use of Optical Fiber Communications Systems Utilizing Laser Diode and LED Sources

IEC and ANSI documents can be ordered from:
Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112–5704
(800) 854–7179

21 CFR 1040, Performance Standard for Laser Products

This document may be obtained by contacting:
Director, Division of Compliance
Bureau of Radiological Health
5600 Fishers Lane
Rockville, MD 20857

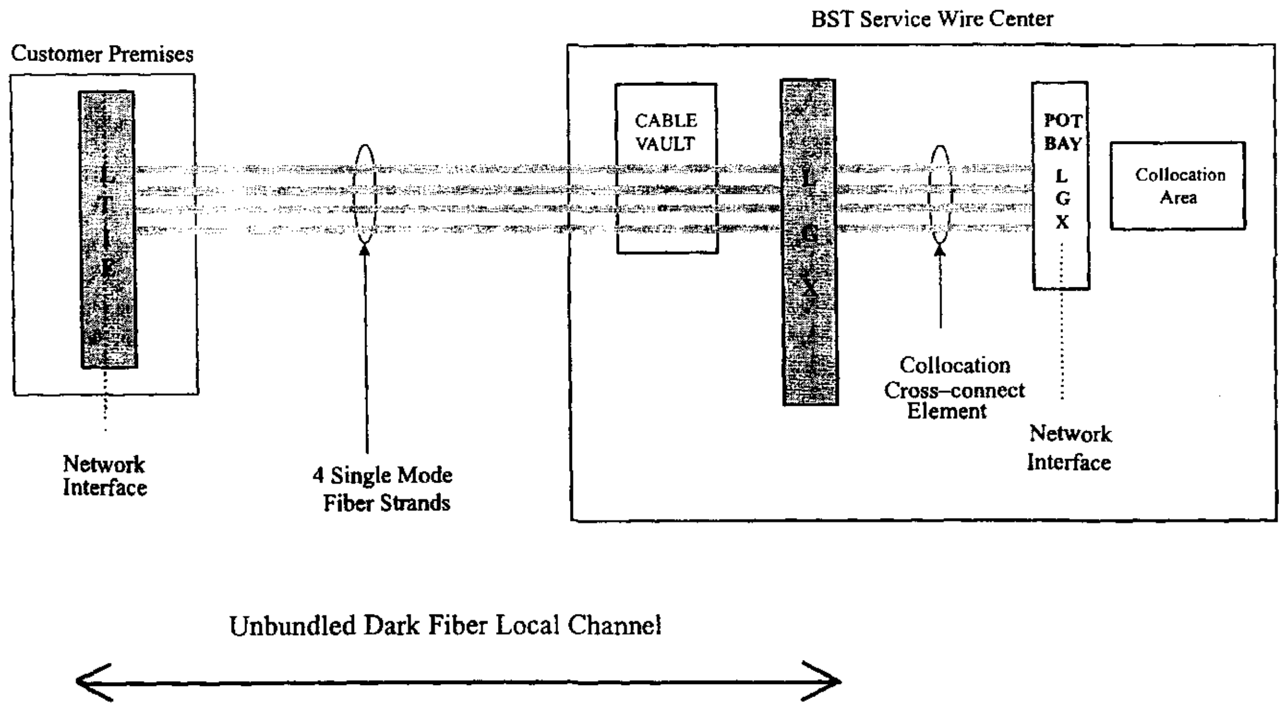
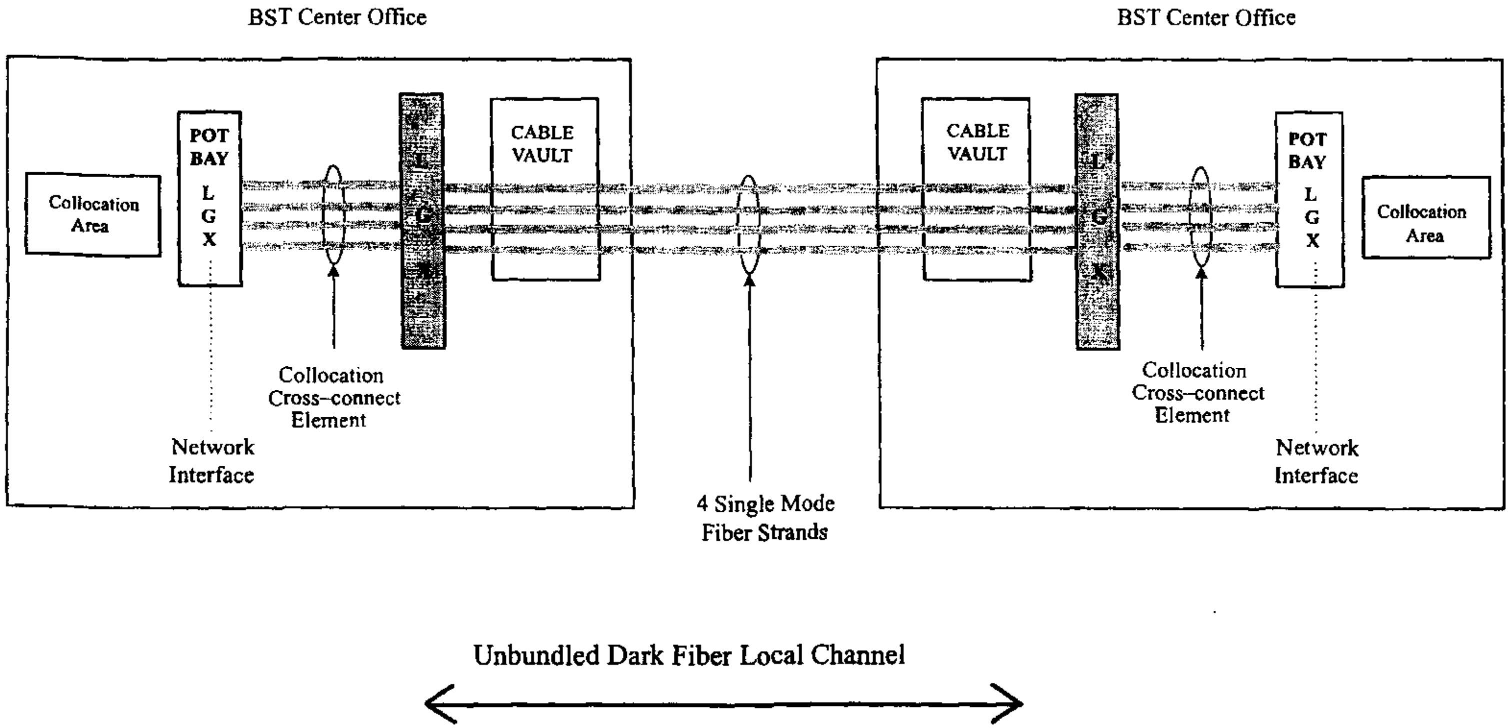


Figure 1 – Unbundled Dark Fiber Customer Premises to BST Serving Wire Center

LTIE	Lightguide Terminal Interconnection Equipment
LGX	Fiber Distribution Frame
POT BAY	Point of Termination Bay

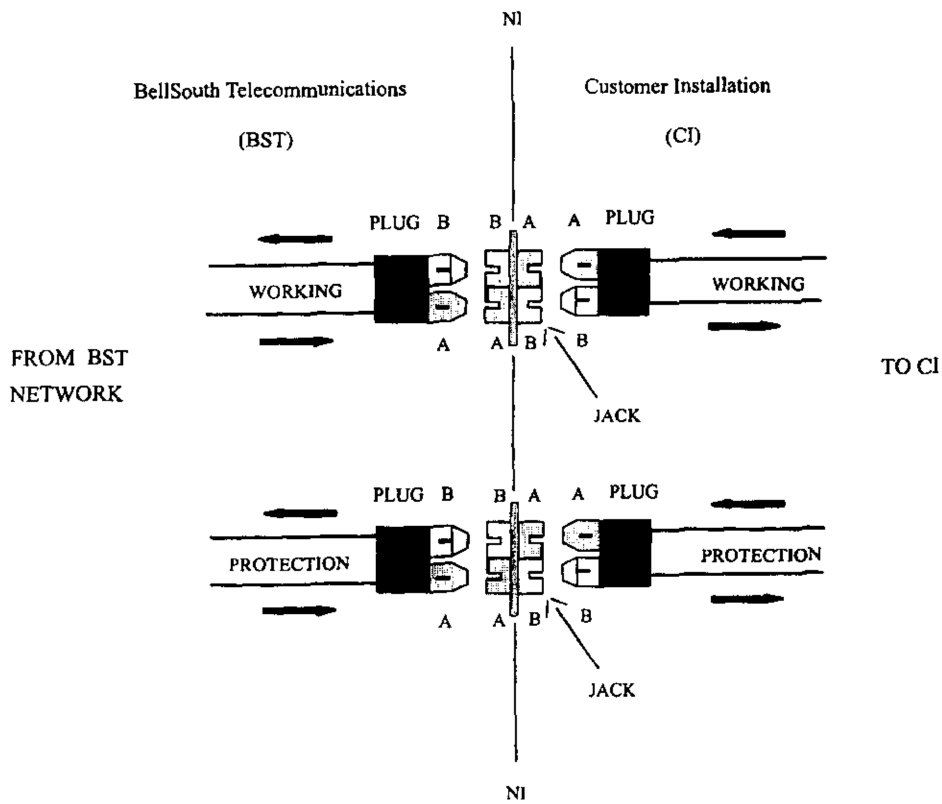
Note: The arrangement shown above is applicable to Physical Collocation. Current polices concerning recombination of elements will be adhered to.



LTIE	Lightguide Terminal Interconnection Equipment
LGX	Fiber Distribution Frame
POT BAY	Point of Termination Bay

Note: The arrangement shown above is applicable to Physical Collocation. Current polices concerning recombination of elements will be adhered to.

Figure 2 – Unbundled Dark Fiber BST Central Office to BST Central Office



NOTES:

1 LIGHT LEAVES "A" PLUG AND ENTERS "A" JACK
2 LIGHT LEAVES "B" JACK AND ENTERS "B" PLUG
3 JACK AT NI PROVIDED BY BST (OPTIONALLY MAY BE PART OF OTHER NETWORK EQUIPMENT)
4 A SINGLE FIBER IS USED FOR EACH DIRECTION OR TRANSMISSION
5 FOR 4 FIBER INTERFCE BOTH WORKING AND PROTECTION PROVIDED

→ DIRECTION OF LIGHT

Figure 3 – 4 Fiber Optic Mechanical Network Interface

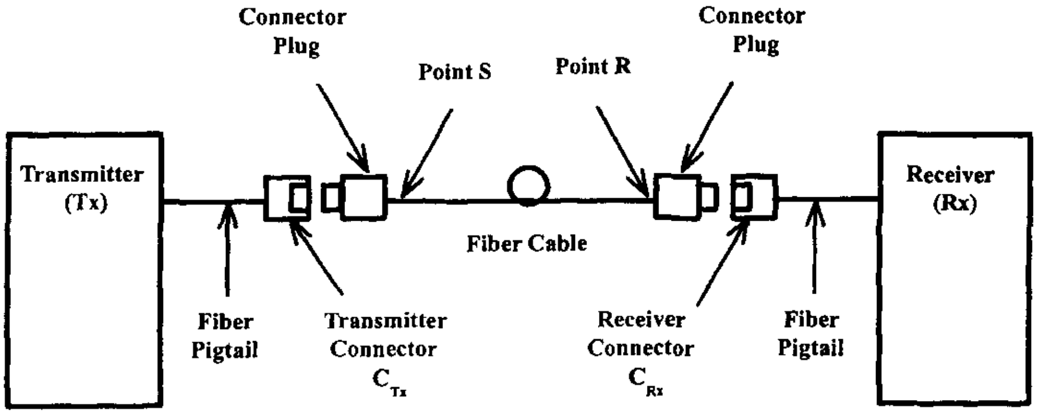


Figure 4 – Optical System Interfaces (Points S and R)

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